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Edward Lyman Morris

EDWARD B. CHAMBERLAIN

(WITH PORTRAIT)

The sudden death of Edward L. Morris on September 14, last, is a loss not easy to estimate. He was by preference a student of systematic botany, but long experience as a successful teacher, and active work as a museum curator, gave him a breadth of scientific training and an appreciation of popular and scientific points of view that are not often combined in those whose position makes them the interpreters of science to the public.

Those who knew Mr. Morris feel that their personal loss overshadows everything else. He had to an unusual degree the genial charm of manner that makes and retains friends, and a loyalty that takes no account of time or effort spent in helpful service. His daily life was so full of patience, cheerfulness, and sympathy, that few realized how great, at times, was his own burden. Even when his own life was full of trouble, he was never without the characteristic cordial greeting for everyone he met. With high ideals and the strong convictions that accompany them, he was frank in the expression of opinion, but at the same time modest in statement and considerate of the views of those from whom he differed. The affectionate respect of his associates and the coöperation they gave him are striking testimonials to his own personality.

In his own work Mr. Morris set for himself a severe standard, and demanded like faithfulness from others; yet he worked with

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an enthusiasm that enlivened dry detail and routine. Whatever he did showed painstaking method, sincerity of purpose, and devotion. As a colleague has written of him, "He put his heart as well as his conscience into his work." He was a patient investigator and a close observer, but willing to defer any conclusion until he had a first-hand knowledge of the facts. This desire for truthfulness made him chary of publication; there was so often some minor point that required more study for a complete understanding of the case.

The facts of Mr. Morris's life are, briefly, as follows:—He was born at Monson, Mass., October 23, 1870, the son of Edward Franklin Morris and Louise Janette Clapp, and his youth was spent in the vicinity of his birthplace. At as early an age as eleven, he began the systematic study and collection of the plants of the township, continuing his collecting throughout his preparatory school course. Entering Amherst College in the autumn of 1888 from Monson Academy, he was given special credit for the botanical work already done, and an opportunity to continue it in connection with the college museum. During his third and fourth college years he had especial privileges for advanced work in botany and zoölogy, and was in charge of the college museum.

Obtaining the bachelor's degree from Amherst in 1891, he spent one year at the Museum of the Worcester Natural History Society, one year in graduate study at Harvard, and two years as instructor at Amherst, which conferred upon him the degree of M.A. in 1895.

Of his work at Amherst Professor Tyler says, in a letter recently received: "It always seemed as if he was working purely for the enjoyment of it. He was a very hard worker, and made his students work. The best men did so because they caught his spirit, the others because they had to. He made things very clear, and always knew what to tell and how much to leave to the student to find out. He never made his teaching a mere memorizing of dry details."

In 1895 Mr. Morris removed to Washington, D. C., and for twelve years was connected with the school system of that city, for the last seven years being head of the department of biology. His progressive teaching here developed a course in biology

that reached the life and activities of young people. He always taught as if in the laboratory, arousing the interest of his students, stimulating them to seek first-hand knowledge, teaching them that biology was a matter of everyday life, and training them to think clearly and hard. During the year 1907, Mr. Morris resigned his position in Washington to become curator of natural science in the Museum of the Brooklyn Institute of Arts and Sciences, a position which he held at the time of his death. For one year, also, after the resignation of Dr. Lucas, he was acting curator-in-chief. This position gave him the chance to develop the ideas of the educative value of museum collections that he had long held. Believing that exhibition specimens should always arouse the desire for further information, he not only saw that the books furnishing such knowledge were close at hand, but insisted that every visitor should have, if he desired, the opportunity of personal conversation with the curator.

In addition to professional duties, Mr. Morris found the time to take an active part in general scientific work, his own motto for such things being, "Make both tie for first place." In Washington he was a member of the botanical, biological, and entomological societies, and of the Cosmos Club, but most closely identified with the Washington Biologists' Field Club, of which he was a founder and leading spirit. No one who knew him at "The Island" could fail to see how very close to his heart the success of the Club was, or forget how enthusiastically he entered into the plans for its development. Even after leaving Washington he kept in close touch with all that went on at the Club, and never failed to revisit it when circumstances permitted. He had made a large collection of plants from the Club property, which he hoped to make the basis for a detailed catalogue.

For years Mr. Morris's especial pleasure had been the systematic study of the Plantaginaceae, of which he had accumulated a large amount of material, many species being represented by alcoholic as well as ordinary herbarium specimens. It was a source of keen regret to him that increasing duties encroached upon the leisure hours that he preferred to spend upon his collections. The characteristic desire for accuracy delayed the publication of many conclusions that had already been attained,

conclusions that it is hardly possible to reconstruct from the notes available.

Besides what has already been mentioned, Mr. Morris was for a short time associate editor of School Science and an associate examiner on the College Entrance Examination Board. At the time of his death he was editor of the Torrey Botanical Club, of which he had been a member since 1901. In 1898 he collected for the United States National Herbarium on the Florida Keys, and in 1900 was an assistant upon the staff of the United States Fish Commission in West Virginia. For four years he was a special plant expert of the Department of Agriculture, doing field work in Oregon, along the Great Lakes, and in Iowa. In 1908 Mr. Morris was secretary of the Nomenclature Commission of Section G of the American Association for the Advancement of Science, and in 1911 was elected a fellow of the Association.

Mr. Morris was twice married, his first wife being Florence Syvret, of Charlton, Mass., who died in 1903. In 1907 he married Mary E. Bedell, of Washington, D. C., who, with a son, survives him.

NEW YORK CITY

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The ferns and flowering plants of Nantucket—XI

EUGENE P. BICKNELL

CELASTRACEAE

*CELASTRUS SCANDENS L.

Rare; it is found sparingly on Coskaty entwined with wild rose and red raspberry near the harbor shore, and in Shawkemo, where it is massed thickly along a low bank back of the beach. Flower buds June 4, 1909; first flowers June 2, 1911.

ACERACEAE

ACER RUBRUM L.

In swamps and low grounds. It is commonly of no greater stature than a shrub, but in sheltered thickets becomes a well-developed tree, and in Beechwood has attained a height of not less than thirty to thirty-five feet, the trunks thirty to thirty-five inches in basal girth. The leaves of different trees are widely variable, sometimes appearing much like those of *Acer carolinianum*, again taking an elongated form with narrowly cleft attenuate and sharply cut lobes.

*ACER CAROLINIANUM Walter.

Frequent in boggy thickets, sometimes side by side with those forms of *Acer rubrum* with which it is most sharply in contrast. It is a tree of marked individuality when appointed in its true features but these are not always well expressed and its divergence from the red maple cannot be said to have passed into a fixed separation. In its most characteristic forms the small thickish leaves, rather clustered at the ends of the branchlets, are of rounded outline and broadly notched into three short lobes, the blades, only 4–6 cm. long and wide, having the upper surface of a dark shining green, the lower surface conspicuously whitened and more or less pubescent.

*ACER SACCHARINUM L.

A. dasycarpum Ehrh.

About two miles from the town scattered among an open growth of pines off the Wauwinet road are to be found a few small silver maples not over three or four feet in height. They were first observed in 1909.

*ACER PLATANOIDES.

The Norway maple has been little used on Nantucket, but is self-seeded in planted grounds and has occasionally grown up into small trees in neglected places.

*ACER PSEUDO-PLATANUS L.

Many fine sycamore maples shade the streets of the town and produce a numerous progeny of seedlings some of which persist and grow into small trees in out of the way places. In full flower along the streets June 6, 1909.

The three introduced maples here mentioned have only the slenderest claim to be included in the island's wild flora and are reported mainly for purposes of record as widely cultivated trees which are tending to become naturalized.

BALSAMACEAE

IMPATIENS BIFLORA Walt.

Common in low grounds often bordering thickets or growths of rankly growing taller plants. A form occurs having very pale or whitish spotted flowers. First flowers July 1, 1912; blooms through September.

VITACEAE

VITIS LABRUSCA L.

Very common generally and in many places conspicuous from its luxuriant growth. It thrives in low thickets draping the shrubbery and strays into open places, trailing among the grass and herbaceous plants or even sprawling in bare sandy fields. Flower buds June 12, 1909; first flowers June 17, 1908; June 18, 1910; well-formed green fruit June 27, 1912.

The fruit may be of the largest size and deep purple or amber purple in color, or much smaller, more numerous and crowded

in the clusters, and greenish or greenish purple even when fully ripe. This pale-fruited form is locally abundant on Marthas Vineyard, where it is often wholly green at maturity and is known to the islanders as the white wild grape. I did not myself see it growing there, but, on Sept. 28, 1911, was shown several large sacks filled with the perfectly ripe green fruit which, in gathering, had been kept separate from the usual purple kind.

VITIS AESTIVALIS Michx.

Found only on the eastern side of the island, where it is frequent or locally common in wet or dry thickets sometimes actually intertwined with *Vitis Labrusca*. It occurs in Shawkemo, Pocomo, Coskaty, and Squam, and south to Tom Never's Pond. Comes into flower rather later than *V. Labrusca*. Flower buds very small June 7, 1911, and June 13, 1908; first flowers June 26, 1910; still in bloom July 11, 1912. It appears to fruit only sparingly on Nantucket, although bearing abundantly on Marthas Vineyard. Fruit small and green Aug. 13, 1906; becoming purplish Sept. 11, 1907. On Marthas Vineyard much of the fruit was still unripe Oct. 5, 1912.

A very old vine near Abram's Point measured twenty-one inches around close to the base and seventeen inches a foot above.

PARTHENOCISSUS QUINQUEFOLIA (L.) Planch.

In thickets, either in low grounds or on the dry plains, sometimes trailing over banks clothed with crisp lichens and bearberry or even thriving in exposed white sand. Flower buds barely visible June 1, 1909, and June 14, 1911; no open flowers up to July 12, 1912.

The leaflets vary from glabrous to thickly pubescent with silvery hairs on the lower surface and to some extent on the upper surface also; this pubescence may extend thinly along the petioles but seems always to be absent from the branchlets and tendrils. It is a character that has been adduced as distinctive of *Parthenocissus hirsutus* (Donn) Small, but as to the pubescent Nantucket plant there seems little reason to doubt that it is merely a condition of the common Virginia creeper. The leaves of young plants are often very pubescent, and in older plants the lower leaves may be pubescent and the later ones quite glabrous.

MALVACEAE

MALVA ROTUNDIFOLIA L.

An abundant weed, flowering freely from May through September and doubtless until frost.

*MALVA VERTICILLATA L.

The herbarium of the Nantucket Maria Mitchell Association contains a specimen of this mallow, collected by Mrs. Nellie F. Flynn, bearing the record "Waste place, Sept. 22, 1902."

*MALVA MOSCHATA L.

Several white-flowered plants in full bloom July 9, 1912, in a vegetable garden at Surfside; Surfside, Aug. 1909, Mrs. Mary A. Albertson; lane off Madequet road, 1905, Mrs. Eleanor W. Morgan, *fide* F. G. Floyd.

*ALTHAEA ROSEA Cav.

Freely spontaneous by street sides and in neglected places about the town and appearing occasionally in waste lots in the suburbs. The seedling plants begin to spring up at the end of May. Just in flower in several waste spots July 12, 1912.

HIBISCUS MOSCHEUTOS L.

When in bloom the rose-mallow is conspicuous at a number of the shore ponds on the northern and eastern sides of the island, but it seems to be quite wanting about the ponds on the south shore. At most of its localities it is not abundant, although growing in profusion at a few places. It is found at Capaum Pond, Reed Pond, Monomoy, Shimmo, Squam Pond, and on Coskaty, where it was in full bloom Aug. 16, 1906. Flowers observed as late as Sept. 11, 1907.

Mr. Floyd's notes refer to a form having white flowers with a crimson eye found by a small pond in Monomoy by Miss Mary Foster Coffin. It is not improbable that this may have been *Hibiscus oculiroseus* Britton, which is not rare on Long Island.

HYPERICACEAE

ASCYRUM HYPERICOIDES L.

Long known from Nantucket, the northeastern limit of its range, but not at all a scarce plant there, as has been supposed.

It is, however, confined to the eastern side of the island, where it is locally common from Wauwinet to Quidnet, extending west to Beechwood and south to beyond Sachacha Pond. In full flower Aug. 7, 1906; continues to bloom until late in September. It often spreads out into patches of considerable size, which become noticeable from their light green color as early as the middle of June.

HYPERICUM ADPRESSUM Bart.

Common about several ponds in Polpis and Saul's Hills; west of Sachacha Pond; Waqutuquaib Pond; Miacomet Pond; a single early flower July 11, 1912; in full flower Aug. 7, 1906; Sept. 1, 1904; some flowers remaining Sept. 18, 1907. The young plants have become several inches high by the middle of June.

Early in the season this St. John's-wort may be seen in small ponds either wholly submerged or showing emersed leafy tips. Later, when the waters have fallen, such plants often develop with unusual vigor, becoming fully two feet high with the leaves proportionately enlarged and the submerged portion of the stem greatly thickened with spongy tissue (var. *spongiosum* Robinson). Where colonies of the plant extend back from a flooded shore a complete gradation may be traced from this spongiose aquatic condition to the more usual terrestrial state. The latter comes earliest into bloom, the most dwarfed examples of the driest situations flowering first and often precociously.

The spongiose tissue is doubtless homologous with the aerenchyma produced on the floating stems of *Decodon verticillatus*. A slight but evident spongiose enlargement of the lower part of the stem is sometimes seen in *Hypericum canadense* and in *Hypericum boreale* when these low ground plants grow in very wet places.

HYPERICUM PERFORATUM L.

One of the bright-flowered weeds of fields and waysides, and scattered widely over the plains and commons. First flowers June 27, 1910; June 29, 1912.

HYPERICUM PUNCTATUM Lam.

Not common but found sparingly at a number of widely separated stations, mainly on the eastern side of the island; not

observed west of Maxcy's and Hummock Ponds. Plants of full size June 15, 1911; small flower buds June 11, 1912; in full flower and with some mature pods Aug. 16, 1906. So far as observed, the Nantucket plant has always sessile broadly clasping leaves.

*HYPERICUM BOREALE (Britton) Bicknell.

This is the commonest *Hypericum* of the island, abounding in low grounds, damp or wet sandy places, and pond shores. It is sometimes aquatic, inhabiting deep water with the habit of a *Callitriche*, the elongated leafy stems either wholly submerged or their tips emersed. In wet sand it may become strongly stoloniferous, putting forth prostrate basal offshoots which reach a length of several inches and root at intervals, sending up small flowering stems and terminating in a cluster of stems from the rooted tip. The young plants become recognizable early in June. Just in flower Aug. 13, 1906, remaining in bloom through September.

HYPERICUM MUTILUM L.

Common in low grounds, often with its characters unusually well emphasized, the broadly clasping leaves becoming as large as 3 cm. long by 2 cm. wide. The earliest leaves are observable at the end of May and the young plants take definite form early in June. In full flower Aug. 13, 1906; flowering through September.

*HYPERICUM MAJUS (A. Gray) Britton.

Infrequent, growing in damp places. West and southwest of the town; Trot's Swamp; Miacomet Pond; Quaise. Just in flower Aug. 11, 1906; in full flower Sept. 8, 1904; Sept. 12, 1907.

HYPERICUM CANADENSE L.

Common in low grounds and wet sandy places. Leaves often almost filiform linear. Plants very small May 30, 1909; a single early flower June 20, 1908, and July 3, 1912; in full flower and with mature capsules Aug. 13, 1906; continues in flower through September.

***Hypericum dissimulatum** sp. nov.

Erect, often from an oblique or horizontal rooting base, commonly 1.5–3 dm. high, exceptionally up to 5.5 dm., not often

branched below the middle; leaves narrowly oblong, obtuse, sessile or subclasping, 3–5-nerved, 1–3 cm. long, 2–6 mm. wide; branches slender, openly ascending, bearing dichotomous many-flowered bracteolate cymes, the bracts subulate; sepals oblong to lanceolate, obtuse or acutish, equaling or shorter than the capsules; capsules greenish to reddish purple, small, 2–4 mm. long, ellipsoid to conic-ovoid.

Maine to Maryland and North Carolina. Type from Nantucket, damp roadside west of the town, Sept. 20, 1899, in flower and fruit, in herb. N. Y. Botanical Garden. Also collected on Nantucket Sept. 8, 1904, Miacomet Pond, and Sept. 9, 1904, near the town.

This plant has been known to me for many years, having been collected first in York County, Maine, then on Nantucket, on Marthas Vineyard, where it is more common than I have found it elsewhere, and on Long Island. It is found in damp sandy places, usually growing with *H. canadense*, *H. majus*, *H. mutilum*, and *H. boreale*, one or all, and is not less distinct in appearance from each of them than are they among themselves. It differs from *H. canadense* in broader often subclasping leaves, more diffuse inflorescence, and smaller often ellipsoid capsules. Narrower leaves, more spreading and compound inflorescence, and smaller capsules distinguish it readily from *H. majus*, while it stands apart from *H. mutilum* by stricter, less branched habit, narrower less clasping leaves and longer, or more ellipsoid, purple capsules. Certain specimens approach *H. canadense* in the form and color of the pods, other examples seem nearer to *H. mutilum*, and it may well be questioned whether it be not a hybrid of these two species or, indeed, partly of *H. canadense* and *H. boreale* as some specimens might seem to suggest. But all of our small St. John's-worts of this group are nearly related and, considering the extended coastwise range of *H. dissimulatum*, as good reasons appear for viewing it as one of a chain of close species as for surmising that it may be a cross.

In addition to material from Maine, Nantucket, Marthas Vineyard, and Long Island, collected by myself, the following specimens may be cited:

In herb. N. Y. Botanical Garden:

RHODE ISLAND: Kingston, Aug. 21, 1906, *E. S. Reynolds.*

PENNSYLVANIA: Smithville, Lancaster County, *J. K. Small & J. J. Carter.*

MARYLAND: Hyattsville, Aug. 13, 1904, *H. D. House.*

NORTH CAROLINA: Mica, June, 1898, *C. W. Hyams.*

In herb. Columbia University:

NEW YORK: Springfield, L. I., 1896, *Elizabeth G. Knight;* New Dorp, Staten Island, Aug. 31, 1890, *N. L. Britton.*

SAROTHRA GENTIANOIDES L.

Abundant in dry sandy places, stems appearing June 15, 1911; in full flower in September. The plant may be actually minute, its simple stem bearing only a single flower, or densely branched to form a firm convex mass 1–1.5 dm. in diameter.

TRIADENUM VIRGINICUM (L.) Raf.

Very common in wet swamps and about the borders of muddy ponds. Earliest leaves May 31, 1908; no flowers remaining in September.

ELATINACEAE

ELATINE AMERICANA (Pursh) Arn.

Common in some of the sandy ponds, growing in shallow water near the shore. Observed especially in Maxcy's Pond, Miriam Coffin Pond, and Miacomet Pond. At Maxcy's Pond on Sept 12, 1907, it grew as profusely on the damp sand where the water had receded as beneath the surface along the shore. At one spot in heavy mud ten yards or more from the water's edge it had formed compacted moss-like mats, some of them six inches across, a mode of growth remarkably unlike that of the submerged plant. Correlated with this difference in habit ran a variation in characters which was brought out strikingly by comparison of the living plants. In water and on damp sand the individual plants were separate in growth, uniformly simple-stemmed, and whitish or pale green in color. In the mud form the matted stems were often divergently much branched and the general color a lively green tinged with reddish or purple, these tints deepening on the capsules into bright crimson; instead of greenish white the petals were rose color and were sometimes as large as 1.5 mm. in breadth. The capsules, some being four-valved, were larger than those of

the submerged plant and of a distinctly different form, depressed-subglobose and wider than long instead of broadly obovoid and longer than wide; actual measurements were 2 mm. wide by 1 mm. long in the terrestrial plant and only 1–1.5 mm. wide by 1 mm. long or more in the normal aquatic form.

CISTACEAE

CROCANTHEMUM CANADENSE (L.) Britton.

Helianthemum canadense Michx.

The typical plant is not common and is rather local in its distribution, giving place to the following, which is everywhere abundant. It is however frequent in the oak barrens towards Siasconset and is found sparingly in Quaise, on the plains towards the south shore, on Great Neck and elsewhere. No flower buds visible June 3, 1909; first flowers June 11, 1909; in full flower June 19, 1910; a few flowers remaining June 30, 1912. Reduced petaliferous flowers are often produced in September.

***Crocanthemum dumosum** sp. nov.

Similar to *Crocanthemum canadense* but lower and of more branched and spreading habit, commonly diffuse and semi-prostrate or ascending, the pubescence somewhat more densely and softly canescent, intermixed with scattered non-stellate longer hairs and some minute glandular hairs of a reddish color; leaves smaller and shorter than those of *C. canadense* and of a more bluish green color, mostly oval and elliptic and obtuse, often very small and crowded on the short divergent branchlets; flowers slightly paler than in *C. canadense;* mature calyx often larger, the sepals very broad and mostly acuminate, usually bearing reddish papillae on the outer surface and reddened glandular or viscid hairs in the pubescence; primary inflorescence an ascending succession of single petaliferous flowers succeeded by rather numerous flowers intermediate in size and character between these and the later apetalous ones.

Well marked and abundant all over Nantucket, combining with such common and characteristic island plants as *Amelanchier nantucketense, Ilex fastigiata,* and *Linum intercursum* to stamp the flora with a signally distinctive character. It is found also on Marthas Vineyard and on the Hempstead Plains of Long Island.

Blooms rather earlier than *C. canadense*. First flowers May 31, 1909, and quite generally in bloom June 1; June 3, 1911; still some flowers June 26, 1910. At one station a number of clustered plants bore flowers so pale in color as to appear almost white.

Type from Nantucket, Sept. 21, 1899, in herb. N. Y. Botanical Garden.

The typical form of the plant has an unlikeness to typical *Crocanthemum canadense* greater than appears between some other closely allied species within the genus, and this diversity of aspect becomes especially striking when, as is sometimes the case, the two are found growing near together. Typical *C. canadense* is a taller erect plant with lighter-colored stems and longer and more slender and simple ascending branches, narrowly oblong or oblanceolate leaves tapering to the base and the acute apex, brighter green on the upper surface and less densely pubescent. Ordinarily it holds very true to these characters, showing little tendency to marked variation. In several instances where the two plants growing near together allowed a close comparison of the open flowers, those of *C. dumosum* were seen to be notably the larger, the acuminate sepals reaching a length of 8–10 mm. and reddened with glandular hairs and papillae, while those of *C. canadense*, narrower and mostly obtuse, were but 5–7 mm. long and only obscurely if at all glandulose. These differences are not, however, always so well marked. Nevertheless *C. dumosum* is evidently a strongly established derivative of *C. canadense*, even if it be not yet wholly disconnected from that species. It has been a recurring source of confusion to not a few Nantucket collectors and it seems altogether expedient to dispose of it as a stumbling block by giving it identity by a name.

*CROCANTHEMUM MAJUS (L.) Britton.

Helianthemum majus B.S.P.

Rather common on the plains towards the south shore; elsewhere very local although widely scattered, but wanting over a great part of the north and east sides of the island. No visible flower buds June 22, 1910, July 2, 1912; first flowers July 10, 1912. small petaliferous flowers sometimes appear in September.

***Crocanthemum propinquum** Bicknell.

Helianthemum propinquum Bicknell.

Rather local, but not uncommon in dry open places or along sandy roadways through pine barrens. Common on Marthas Vineyard. In full bloom June 26, 1910; not many flowers left June 29, 1912; a few belated flowers July 11, 1912.

This plant, not at all uncommon from Nantucket to western Long Island and doubtless further south, appears to remain almost unknown to botanists and seems not to have been reported by any collector since it was first described in Britton's Manual over eleven years ago. In the seventh edition of Gray's Manual it has been quite misunderstood, being mistaken for the plant described in this paper as *Crocanthemum dumosum* and referred to as being probably only a stunted form of *C. canadense.*

I know the plant now much better than when I ventured to give it a name and have found no reason to doubt that it is an unequivocal species, that is to say, one that is organically discrete from those allied species which most nearly approach it, however close the degree of their relationship. Narrow indeed is the interval between this plant and those other convergent species whose distribution it partly shares. But I have not found in this any proof of consanguinity but rather an example of the exceeding closeness in which specific lines may run in perfect security from coalescence or entanglement. The plant is to be viewed critically especially in its relation to *C. majus.* Its clustered primary flowers at once give this indication and mark its distinctness from *C. canadense.* Singularly enough, however, in the later stages of its growth it more nearly resembles the latter, agreeing in color of foliage and slender ascending branches surpassing the primary inflorescence. This character of the mature plant sketches it out clearly from *C. majus,* of strict habit and short close branches, but in its unbranched early-flowering stage, then also of paler foliage, it is almost a reduced counterpart of the larger plant.

To review its differences from *Crocanthemum majus,* it is a much smaller and more slender and flexuous plant, at length more openly and slenderly branched, less densely canescent from the first and finally much greener, the leaves narrower and more

obtuse, often spatulate-linear, and usually on more obvious petioles; the primary inflorescence is of more delicate and open structure, the flower buds elliptic in form rather than ovoid, the calyx becoming notably larger, 8–10 mm. long, and often strongly reddish-tinged, thus equaling in length the largest calices of *C. canadense* as well as corresponding in color, although with narrower sepals and wanting the characteristic pilose hairs; the narrow outer sepals are shorter than in *C. majus*, and the even smaller petals are of rather a brighter yellow; the primary capsules are smaller, thinner-walled, and less broadly ovoid, longer than wide instead of wider than long, and are without the umbonate tip; it is, in fact, much more like the capsule of *C. canadense*, although smaller and narrower; the papillose seeds are also much like those of *C. canadense*.

There is nothing in all this that denotes the plant to be necessarily of mixed strain, nor do my observations lead me to believe that it is a hybrid. It does indeed possess in combination the early flowering time of *Crocanthemum canadense* and the smaller pale yellow flowers of *C. majus*, together with the slender branching of the one and the clustered petaliferous flowers of the other, yet its capsule has not its counterpart in that of either, nor is it intermediate with them, being smaller and less broadly ovoid. The plant stands apart from these companion species also in its small size and more delicate structure, in the prevailing form of the leaves and in its non-cespitose habit. Its slender stems, although sometimes loosely clustered, commonly arise at distinct, even remote intervals along tortuous elongated rootstocks, forming open groups or larger patches, sometimes several feet in diameter. It is rarely found associated with more than one of its close allies, often, indeed, occupying territory where not either one of the others is found at all.

The relationship of *Crocanthemum propinquum* to the little-known *C. georgianum* of the southern states is evidently close, although, according to Dr. Small, the latter possesses the very distinct character, as compared with the northern group of species, of bearing the petaliferous and apetalous flowers in the same clusters.

HUDSONIA ERICOIDES L.

Few plants of Nantucket spread over the island more widely or in greater abundance than this little heathlike species and not one is more conspicuous in the landscape when in full bloom. Nor is there any other that, at flowering time, puts its scene in color with quicker transformation, for there come seasons when it bursts into bloom on all sides in the hours of a single hot morning.

Earliest flowers May 30, 1909, quite generally in bloom June 2; first flowers June 4, 1911, in the early morning, everywhere in flower by noon; abundantly in bloom June 7, 1908, inflorescence becoming brown by the 13th and but few flowers remaining on the 18th; in the season of 1910 it had passed flowering in exposed places June 20, although still blooming freely in the shade of pine groves.

After full bloom it remains for one or two weeks the season's most conspicuous flower, spreading its sheets of gold along the roadways and over acres of plain and hillside, a radiant sight. A few days later the flowers are withered and the wide tracts that had glowed with their color become brown and rusty as if seared by fire.

In open sandy places where this plant has formed the compact circular cushions that are one of its modes of growth, the flowers usually open first close to the ground on the side towards the morning sun, blending together in patches of expanding brightness as they continue to unfold. Gradually as the sun rises overhead the glow of color creeps back along the borders of the tuft, sometimes uniting around its circumference in a golden ring. Soon afterwards the entire tuft has become an unbroken mass of bloom.

Often in midsummer these cushion-like tufts even in the hottest and most exposed sandy spots remain fresh and green in bright contrast to their parched surroundings, calling to mind so remote a comparison as the stones along a woodland brook covered with green moss.

In open pine scrub south of the town on June 5, 1911, several patches of this plant, all near together, bore flowers of palest sulphur-yellow, in striking contrast to the normal bright yellow flowers everywhere about them.

HUDSONIA TOMENTOSA Nutt.

Very abundant, blanketing the dunes and reaches of white sand back of the beaches and occurring on sandy exposures all over the island. It is sometimes found in association with the preceding but seems not to mix readily with any other plant. Close to blooming June 3, 1911; in full flower June 7, 1908, June 15, 1910, and some flowers remaining June 27; last flowers July 2, 1912, on the exposed ocean front at Siasconset, where many plants flower later than in more protected parts of the island. Ordinarily it begins to flower a little earlier than *Hudsonia ericoides*.

LECHEA MINOR L.

Abundant on the eastern side of the island from Wauwinet to Saul's Hills and Siasconset, extending west to Shawkemo and through the South Pasture to Surfside; not seen on the western side of the island. The season's shoots a few inches high June 23, 1910.

LECHEA VILLOSA Ell.

Much less common than the preceding but like it restricted mainly or entirely to the eastern side of the island, having a scattered distribution from Wauwinet to Siasconset and the South Pasture and from Pocomo to Shawkemo and Saul's Hills.

LECHEA MARITIMA Leggett.

One of the island's most common plants, appearing everywhere in dry sandy soil, even to the tops of Saul's Hills. It makes its best growth in pure sand, where it becomes widely branched and densely canescent. In less simple soils amid the low vegetation of the moorland or in partial shade it is more thinly canescent and shorter-branched, having a narrower panicle and closer inflorescence. Such forms take on a likeness to *Lechea juniperina* that seems almost to shadow the origin of that more northern species. Sometimes on rising ground in open growths of pines or other trees it may become very slender and greener, with more scattered leaves and branches, more slenderly branched and open panicle of longer-pedicelled flowers and rather larger fruiting calyx—var. *interior* Robinson.

In full flower Sept. 3, 1904, Sept. 11, 1899; small new shoots

June 15, 1910. In the autumn, sometimes as early as September, the basal shoots may be found beneath the surface of the sand so densely invested with white pubescence as to appear as if coated with hoar frost.

*LECHEA LEGGETTII Britton & Hollick.

L. moniliformis Bicknell.

Not rare on the eastern side of the island from Wauwinet to Polpis, Gibbs' swamp and Tom Never's swamp; one station near Madequecham Pond on the south shore. It is found in low grounds spreading to dry sandy levels near wet places; in one instance it grew on the border of a sphagnum bog, and in another in wet soil along a brackish marsh.

Plants 6 inches high June 24, 1910; flower buds well advanced Aug. 7, 1906; some mature pods Aug. 31, 1904.

This, in its extreme phase, is the plant described by me some years ago as *Lechea moniliformis*. The type specimens, as well as others like them from Long Island, mark a pronounced departure from typical *L. Leggettii*. Other specimens from Nantucket and Long Island are less distinctive and I am in doubt whether it is well to rate the plant as other than a variety of the common species. Nevertheless, it has points of distinction which need no second glance to impress any one who may be familiar with the common inland form of the species, for *L. moniliformis* would appear to be a plant of the coastal plain, and there is as yet no evidence that it does not belong exclusively among our coastal plain species. Moreover it shows this difference in habits from the more inland plant of dry open places and hilly ground, that it is of low grounds often of wet and brackish soils. A better knowledge may show that its distinctive name should be restored, but for the present let it be merged with *L. Leggettii*. I take to be typical of the latter the plant that I used to find among the hills and rocky outcroppings along the Hudson near New York and which, found also in New Jersey and on Staten Island, largely made up the material studied by Leggett and by Britton & Hollick. As compared with this the main distinguishing characters of *L. moniliformis* are the slender and elongated flowering branchlets and the markedly secund and moniliform inflorescence, for in the

typical plant the ultimate inflorescence takes a short corymbulose rather than a slenderly racemulose plan. These flexuous branchlets are often borne on short spreading branches crowded on the upper part of the stem, producing a broadly ovoid or obovoid, often dense and very leafy panicle instead of a more oblong and open one. The leaves, similar to those of *L. Leggettii* proper, are rather longer and more tapering acute and narrowed into more evident petioles 1–2 mm. long. The mature calyx and pod is commonly larger and more elliptic than in the typical plant and is usually further distinguished by its decidedly purplish color; also the capsule is rather more exserted and often more distinctly short-stipitate, and the general pubescence is sparser and of rather longer and looser hairs.

Note.—Lechea racemulosa Lam. was attributed to Nantucket by Mr. Leggett and is reported by Mrs. Owen as having been found there by Mr. Dame. There would seem to be little reason to doubt that these records were based on mistaken determinations.

VIOLACEAE

VIOLA PEDATA L.

The commonest blue-flowered violet of Nantucket, broadcast on the plains and commons and among open growths of scrub pines. The flowers are often small for the species and of deep color, varying to pale lilac and sometimes pure white.

The spring flowers of Nantucket are late in coming, and this violet, which on Long Island colors acres of the Hempstead Plains from April, in early seasons, until the middle of May or, in later seasons, till the end of the month, is commonly in full bloom on Nantucket from late in May until after the middle of June. In the forward season of 1908 no flowers were to be found after June 15, but the following year children on their way to school were seen carrying large bunches on June 6, and it was blooming in profusion as late as June 12. Flowers are occasionally produced in midsummer and, more frequently, in September.

On Sept. 1, 1904, among scrub pines where, earlier in the year, fire had passed, destroying the herbage, many of these violets had sprung up afresh and were in full bloom. The leaves of all differed curiously from their normal form, being narrowly to

broadly cuneate and flabellately cleft into irregular lobes of varying length and breadth. Plants with similar leaves collected June 12, 1908, were rooted deep in heavy yellow sand and, like those of the burned-over tract, had doubtless suffered some disturbance of their normal course of growth.

*VIOLA OBLIQUA Hill.

Viola affinis LeConte. See Bull. Torrey Club **40**: 261–270. 1913.

On a shaded bank at Watts Run, an abundant growth, and sparingly in a not distant thicket in Squam; also in the shade of a willow by a bog hole west of Trot's Swamp. In full flower as late as June 9, 1909.

Becoming 3.5 dm. high, or more; leaves thin, from narrowly to broadly cordate-ovate, attenuate to acuminate, acute, in age widely dilated at base and broader than long, the largest 9 cm. wide, the upper surface with some minute appressed hairs; sepals ovate to ovate-lanceolate, obtuse, flowers often becoming upturned; peduncles of apetalous flowers of very variable length even on the same plant, declined, ascending or sometimes strictly erect and over 1.5 dm. high; capsules mostly blotched with purple, sometimes pale, the expanded valves 7–10 mm. long; seeds pale.

*VIOLA PAPILIONACEA Pursh.

Viola cucullata of authors, not Aiton. See Bull. Torrey Club **40**: 261–270. 1913.

Found only in a boggy meadow about a mile west of the town, growing sparingly with *Viola lanceolata;* in full flower June 1, 1909.

Plants rather small, somewhat tufted from multicipital root-stocks; scapes mostly not longer than the leaves; leaf blades cordate-ovate to triangular-cordate, crenulate-serrate, thinly pubescent on the upper surface with appressed silvery spiculae; sepals narrowly lanceolate, sometimes elongate, ciliolate; flowers pale blue, or deeper blue, much darker towards the throat.

VIOLA LAETECAERULEA Greene.

V. papilionacea of authors, in part, not Pursh. See Bull. Torrey Club **40**: 261–270. 1913.

Found only in the town, where it is frequent by streetsides and in shaded yards, often forming close beds, and appearing as

if introduced. In flower June 3, 1909, June 7, 1911. Petioles more or less pubescent dorsally, sometimes densely villous, but more often glabrous, except towards the base of the blade; blades mostly with some pubescence beneath at the base or along the veins. When growing in damp shaded yards the leaves are thinner and brighter green, resembling those of *Viola obliqua;* plants more deeply set in looser and drier soils have duller leaves of thicker texture, the blades broadly reniform with wide sinus and rounded to the short-pointed apex, the margins more closely crenate-serrate; capsules green.

VIOLA FIMBRIATULA Sm.

Excepting *Viola pedata* no other blue-flowered violet is common on Nantucket. Therefore it might be thought that the purity of the *fimbriatula* line would be wholly uncontaminated, and that variation in the species might be seen in its intrinsic phases free from any influence of hybridization. Nevertheless, the variation shown under this insular seclusion is not less remarkable than is commonly the case elsewhere, where associated species may be supposed to have had their influence. The more common form on Nantucket has ovate-oblong subcordate leaves little if at all incised and often as long as the petioles. A coarser form has longer petioles and larger blades, which become 5 cm. or more wide across the subtruncate base. In bare spots on clayey soil are found very small forms with ovate to ovate-lanceolate subentire leaves narrowed into short petioles and crowded in a close rosette against the ground. In shade among the Miacomet pines there is a form having considerable pubescence but otherwise showing something of the aspect of *Viola sagittata*, many of the narrow and long-petioled leaves being rather deeply cordate and saliently dentate at the base with upcurved acute teeth and, notwithstanding their pubescence, appearing bright green and shining on the upper surface; the flowers are deep purple with the rather narrow petals often crenulate and obscurely pointed.

A series of Nantucket specimens was submitted to Doctor Brainerd who says of them, referring especially to the *sagittata*-like plants: "Your plants are not strictly hybrids but intermediate

forms which have probably resulted from hybridization in the indefinite past. We have no pure *Viola sagittata* in Vermont, but most of your odd forms turn up from time to time in the Champlain valley."

*VIOLA FIMBRIATULA Sm. × OBLIQUA Hill.

A single cluster growing with *Viola obliqua* on a shaded bank at Watts Run, June 9, 1909.

Petioles and peduncles pubescent with short spreading hairs, the leaf blades similarly clothed on the veins beneath, sparsely appressed-pubescent on the upper surface, ciliate; later leaves ovate-oblong and openly cordate, or somewhat attenuate-triangular from a subtruncate base, coarsely and rather closely sinuate-dentate towards the base, the largest 6 cm. wide by 9 cm. long on petioles 10–15 cm. long; apetalous flowers few, mostly weakly developed, the buds lanceolate and acute, their petioles ascending-horizontal or declined.

This plant grew in shade beside a mass of *Viola obliqua*. No *Viola fimbriatula* was found with it, but the specimens are obviously intermediate between these two species, and on Nantucket no others are possibly to be assigned as parents.

*VIOLA ODORATA L.

An old garden plant of the town, here and there strayed along streetsides and established in neglected yards. One particular tuft has grown for many years in a crevice between the paved sidewalk and a brick wall on North Water Street. It was first noticed in 1899, and has been found at the same spot on every subsequent visit to the town, evidencing both the tenacity of the plant and the undisturbed repose of the town streets.

VIOLA LANCEOLATA L.

Very common in bogs and low grounds and in wet sandy soil about the borders of ponds. In full flower May 30, 1908, June 3, 1909, June 3, 1911, and still commonly in flower June 15; some flowers remaining June 25, 1910.

Plants growing with *Viola pallens* and appearing more or less intermediate with it, and others approaching *Viola primulifolia* are not improbably hybrids.

*VIOLA PRIMULIFOLIA L.

Less common than the preceding and often found in drier soils. In full flower May 31, 1908, June 1, 1909; last flowers June 17, 1910, June 15, 1911.

VIOLA PALLENS (Banks) Brainerd.

Common in open sphagnum bogs and meadows and in damp thickets. No flowers left May 31, 1908, June 7, 1909; still blooming June 3, 1910, a few last flowers June 8, 1911.

A form of distinct appearance was found in several wet sphagnum bogs, especially in one near Shawaukemmo Spring. It is strictly glabrous throughout, the scapes and petioles delicately streaked with pink, the leaf blades unusually thick and veiny, becoming as large as 5 cm. in breadth, and varying in shape from long-ovate and deeply cordate to broadly cordate-reniform; petioles sometimes 9 cm. long; longer peduncles 1.5 dm.; capsules green; seeds 1–1.25 mm. long, dark gray to nearly black when mature. Doctor Brainerd, who has examined specimens, regards it as a form of *Viola pallens*.

Note.—*Viola blanda* Willd. which proves to be common on Marthas Vineyard is to be looked for on Nantucket.

NEW YORK CITY

The influence of starch, peptone, and sugars on the toxicity of various nitrates to Monilia sitophila (Mont.) Sacc.

Otto Kunkel

Introduction

Winogradsky and Omeliansky (7) found that the addition of .05 per cent of glucose or asparagin to nitrite-media hindered the development of the nitrate-bacteria. Peptone at a somewhat greater concentration was also detrimental. These substances are widely used in the preparation of culture media, but have been given little attention by investigators of the problems of toxicity.

Fluri (2) has reported that the salts of aluminum render the protoplasm of *Spirogyra* and other water plants permeable and are, therefore, injurious to these plants. He found, however, that if glucose, glycerin, or isodulcitol are mixed with the aluminum salt it loses its power of rendering the protoplasm permeable. Thus the toxicity of aluminum salts to these plants depends upon whether or not glucose, glycerin, or isodulcitol are present in the medium. Quite recently Schreiner and Skinner (4) have reported that the toxicity of the organic poison cumarin is counteracted by phosphates, thus indicating a relation between the organic and the inorganic part of the medium.

In view of these results it has seemed worth while to investigate the influence of organic substances on the toxicity of inorganic salts. It has been my object to determine the toxicity of different salts in the presence of certain inorganic substances that are much used in the preparation of culture media.

Material and methods

I have used the fungus *Monilia sitophila* in all of my experiments and have found it well suited to my purpose. Some of the things that recommend it are as follows: (1) It is a rapid grower. On a favorable medium at room temperature it will produce spores

in fifteen hours. (2) It is able to use as a partial source of its food supply a rather large number of organic compounds. Went (6) has found that it grows well on media containing any one of the following substances: maltose, trehalose, raffinose, saccharose, cellulose, starch, fats, and proteids. This makes it especially suitable for experiments in which the organic part of the medium is to be varied.

All of my cultures were grown in Petri dishes that were previously immersed for at least ten hours in cleaning solution made according to Duggar's method (1). In the preparation of media and for rinsing glassware redistilled water was used.

In the tables that follow, the zero sign indicates that none of the spores on the medium in question had germinated, the minus sign indicates that germination and microscopic growth had taken place, while the plus sign indicates that growth was visible to the naked eye. All cultures were incubated at room temperature (about 22° C.).

In order to determine whether or not the toxicity of various salts to *Monilia sitophila* is influenced by sugars, starch, or peptone, each of these organic substances was used separately in testing the toxicity of the inorganic salts. I have designated the highest concentration of a salt that would permit germination of the spores in a given medium, as the limit concentration for that medium. A number of preliminary experiments were made to determine the approximate value of the limit concentration for each salt in each medium used. The results obtained in a final set of experiments are shown in the tables given below.

EXPERIMENTAL

Monilia will produce a considerable growth of mycelium and will ripen spores on a medium made by adding 5 grams of cornstarch to 95 cubic centimeters of redistilled water. The results obtained in a series of experiments in which different inorganic salts were added to this medium are shown in TABLE I. The concentrations varied from 1.33 molar for potassium nitrate to .000004 molar for zinc nitrate.

The table shows at a glance the increasing toxicity of the nitrates used, in the order in which they are arranged in the table

TABLE I

THE TOXICITY OF INORGANIC SALTS TO MONILIA SITOPHILA GROWN ON STARCH MEDIA

	Medium								Growth after 11 days
1.33	molar	solution	of	potassium	nitrate	+	5%	starch	−
1.06	"	"	"	"	"	+	"	"	−
.80	"	"	"	"	"	+	"	"	+
.53	"	"	"	"	"	+	"	"	+
.26	"	"	"	"	"	+	"	"	+
.13	"	"	"	"	"	+	"	"	+
.667	"	"	"	calcium	"	+	"	"	−
.533	"	"	"	"	"	+	"	"	+
.400	"	"	"	"	"	+	"	"	+
.267	"	"	"	"	"	+	"	"	+
.133	"	"	"	"	"	+	"	"	+
.067	"	"	"	"	"	+	"	"	+
.034	"	"	"	"	"	+	"	"	+
.667	"	"	"	sodium	"	+	"	"	o
.533	"	"	"	"	"	+	"	"	o
.400	"	"	"	"	"	+	"	"	−
.267	"	"	"	"	"	+	"	"	+
.133	"	"	"	"	"	+	"	"	+
.067	"	"	"	"	"	+	"	"	+
.034	"	"	"	"	"	+	"	"	+
.187	"	"	"	barium	"	+	"	"	o
.156	"	"	"	"	"	+	"	"	−
.125	"	"	"	"	"	+	"	"	−
.094	"	"	"	"	"	+	"	"	−
.062	"	"	"	"	"	+	"	"	+
.031	"	"	"	"	"	+	"	"	+
.007	"	"	"	"	"	+	"	"	+
.500	"	"	"	urea	"	+	"	"	o
.250	"	"	"	"	"	+	"	"	o
.125	"	"	"	"	"	+	"	"	o
.063	"	"	"	"	"	+	"	"	o
.050	"	"	"	"	"	+	"	"	−
.025	"	"	"	"	"	+	"	"	+
.013	"	"	"	"	"	+	"	"	+
.006	"	"	"	"	"	+	"	"	+
.050	"	"	"	ammonium	"	+	"	"	o
.038	"	"	"	"	"	+	"	"	−
.025	"	"	"	"	"	+	"	"	+
.013	"	"	"	"	"	+	"	"	+
.006	"	"	"	"	"	+	"	"	+
.0075	"	"	"	aluminum	"	+	"	"	o
.0063	"	"	"	"	"	+	"	"	o
.0050	"	"	"	"	"	+	"	"	o
.0038	"	"	"	"	"	+	"	"	o
.0025	"	"	"	"	"	+	"	"	o
.0013	"	"	"	"	"	+	"	"	−

.0006	molar	solution	of	aluminum	nitrate	+	5%	starch	.....	+
.00133	"	"	"	ferric	"	+	"	"	.....	o
.00067	"	"	"	"	"	+	"	"	.....	−
.00053	"	"	"	"	"	+	"	"	.....	o
.00040	"	"	"	"	"	+	"	"	.....	−
.00027	"	"	"	"	"	+	"	"	.....	+
.00013	"	"	"	"	"	+	"	"	.....	+
.00007	"	"	"	"	"	+	"	"	.....	+
.00133	"	"	"	silver	"	+	"	"	.....	o
.00067	"	"	"	"	"	+	"	"	.....	o
.00053	"	"	"	"	"	+	"	"	.....	o
.00040	"	"	"	"	"	+	"	"	.....	o
.00027	"	"	"	"	"	+	"	"	.....	o
.00013	"	"	"	"	"	+	"	"	.....	−
.00007	"	"	"	"	"	+	"	"	.....	+
.000338	"	"	"	zinc	"	+	"	"	.....	o
.000254	"	"	"	"	"	+	"	"	.....	o
.000169	"	"	"	"	"	+	"	"	.....	o
.000082	"	"	"	"	"	+	"	"	.....	o
.000043	"	"	"	"	"	+	"	"	.....	o
.000034	"	"	"	"	"	+	"	"	.....	o
.000025	"	"	"	"	"	+	"	"	.....	−
.000017	"	"	"	"	"	+	"	"	.....	+
.000008	"	"	"	"	"	+	"	"	.....	+
.000004	"	"	"	"	"	+	"	"	.....	+
.5000	"	"	"	ammonium	tartrate	+	"	"	.....	o
.2500	"	"	"	"	"	+	"	"	.....	o
.1250	"	"	"	"	"	+	"	"	.....	o
.0625	"	"	"	"	"	+	"	"	.....	o
.0500	"	"	"	"	"	+	"	"	.....	o
.0250	"	"	"	"	"	+	"	"	.....	−
.0125	"	"	"	"	"	+	"	"	.....	+
.0063	"	"	"	"	"	+	"	"	.....	+
				redistilled	water	+	"	"	.....	+

from potassium to zinc. *Monilia* made sufficient growth to be easily visible to the naked eye in the starch medium containing potassium nitrate at a concentration of 0.8 molar or less, while at a concentration of 1.33 molar the spores germinated and produced microscopic growth. In a starch medium containing calcium nitrate at a concentration of 0.667 molar, the spores germinated but produced such a small amount of mycelium that it could be observed only with the aid of the microscope. It is interesting to note that after three days no germination had taken place in this medium. This shows that in such concentrations growth is very slow. In all media containing calcium nitrate at a concentration of 1.33 molar or less, there was abundant growth.

When sodium nitrate at a concentration of 0.533 molar was combined with the starch medium no germination occurred. When the concentration was 0.400 molar a small amount of growth was obtained. In still lower concentrations enough mycelium was produced to be easily visible to the naked eye. It was found that growth was much retarded in media containing the higher concentrations of sodium nitrate. This shows that near the limit concentration the rate of growth of *Monilia* decreases as the amount of sodium nitrate is increased.

Barium nitrate in the starch medium at a concentration of 0.187 molar inhibits the germination of the spores. At a concentration between 0.156 molar and 0.094 molar, the spores germinate but produce such a small amount of mycelium that it is not visible except under the microscope. At a concentration of 0.062 molar or less, good growth was obtained.

When the concentration of urea nitrate in the starch medium was 0.125 molar, the spores were unable to germinate. When the concentration was reduced to 0.063 molar, the spores germinated but produced such a small amount of mycelium that it was not visible to the naked eye. Good growth was obtained when the concentration of urea nitrate was 0.05 molar or less.

In starch media containing ammonium nitrate at a concentration of 0.05 molar none of the spores germinated, but when the concentration was 0.038 molar, they germinated and produced microscopic growth. When the concentration was reduced to 0.025 molar or less, abundant growth occurred.

Aluminum nitrate in starch media at a concentration of 0.0025 molar inhibits the germination of the spores. At a concentration of 0.0013 molar the spores germinate and produce microscopic mycelia, while at concentrations of 0.0006 molar or less, good growth is obtained.

Ferric nitrate in starch media is quite toxic to the spores of *Monilia*. In concentrations of 0.00027 molar or less, good growth was obtained, but in more concentrated media little or no growth occurred.

Silver nitrate is even more toxic than ferric nitrate; when its concentration was 0.00027 molar, the spores germinated, but produced only microscopic mycelia. In more concentrated media no germination took place.

Zinc nitrate in starch media is far more toxic than any of the other nitrates used; at a concentration of 0.000034 molar, it inhibited the germination of spores. In a concentration of 0.000025 molar, the spores germinated and produced microscopic mycelia, but when the zinc nitrate was used at a concentration of 0.000017 molar or less, abundant growth was obtained.

Ammonium tartrate is the only organic salt that was tried in these experiments. In starch media it is slightly more toxic than ammonium nitrate. In a concentration of 0.025 molar, the spores germinated but produced only microscopic mycelia, while in a like medium containing the same concentration of ammonium nitrate abundant growth was obtained.

As shown by TABLE I zinc nitrate is the most toxic substance used in starch media. If its limit concentration be taken as one then the limit concentrations of the other nitrates in the same medium may be expressed, by comparing equimolecular concentrations, approximately by the following numbers: silver nitrate, 5; ferric nitrate, 26; aluminum nitrate, 52; ammonium nitrate, 1,520; urea nitrate, 1,600; calcium nitrate, 16,560; and potassium nitrate, 53,200.

To show at a glance the relative toxic values of the various substances used, they are given in the order of their toxicity in TABLE II. That toxicity does not seem to be related to the valence of the kation is also shown by this table.

TABLE II

THE RELATIVE TOXICITY OF VARIOUS SALTS IN STARCH MEDIA

Valence of kation	Toxic concentration		Salt	
Monovalent	1.33	molar	potassium	nitrate
Divalent	.464	"	calcium	"
Monovalent	.400	"	sodium	"
Divalent	.156	"	barium	"
Monovalent	.040	"	urea	"
Monovalent	.038	"	ammonium	"
Monovalent	.025	"	ammonium	tartrate
Trivalent	.0013	"	aluminum	nitrate
Trivalent	.00067	"	ferric	"
Monovalent	.00013	"	silver	"
Divalent	.000025	"	zinc	"

The table shows, in the case of each salt, the greatest concentration at which growth was obtained when the salt was used

in starch media. A comparison of equimolecular concentrations shows that of all the nitrates used, potassium nitrate is the least toxic and zinc nitrate is the most toxic to *Monilia* when it is grown in a starch medium. Beginning with the least toxic, the order of toxicity of the nitrates in starch media is as follows: potassium nitrate, calcium nitrate, sodium nitrate, barium nitrate, urea nitrate, ammonium nitrate, aluminum nitrate, ferric nitrate, silver nitrate, and zinc nitrate. Having thus determined the degree of concentration at which the different nitrates are toxic to *Monilia sitophila* in starch media, experiments were made in which the organic part of the medium was varied for the purpose of determining whether or not the toxicity of these salts can be modified by the presence of one or another of the organic substances commonly used in making media. The organic substances tried are peptone, glucose, fructose, and galactose. The results obtained in these experiments are shown in TABLES III to VIII.

As shown by TABLE III, barium nitrate in peptone media at a concentration of 0.133 molar inhibits the germination of the spores of *Monilia*. In a starch medium containing barium nitrate at a concentration of 0.156 molar, the spores germinate and produce a small amount of mycelium. This shows that barium nitrate is more toxic in peptone media than in starch media. No concentration of barium nitrate shown in TABLE III was of sufficient strength to inhibit germination and growth in the presence of glucose. There was, however, a very small amount of mycelium in the media containing the barium nitrate at a concentration of 0.167 molar. This indicates that the toxic dose in glucose media is near the concentration 0.167 molar. The toxicity of barium nitrate in starch media and in glucose media is approximately the same. Its toxicity in peptone media is much greater than in glucose media or in starch media. In fructose media its toxicity is approximately the same as in starch and glucose media but is much less than in peptone media. At a concentration of 0.1 molar, barium nitrate in the presence of galactose inhibits the germination of spores. Its toxicity in galactose is approximately the same as in peptone, but is much greater than in starch, glucose, or fructose.

At a concentration of 0.033 molar, aluminum nitrate in peptone

TABLE III

THE TOXICITY OF BARIUM NITRATE IN PEPTONE, GLUCOSE, FRUCTOSE, AND GALACTOSE MEDIA

Medium	Growth after 11 days
.167 molar solution of barium nitrate + 5% peptone	o
.133 " " " " " + " "	o
.067 " " " " " + " "	−
.033 " " " " " + " "	+
.017 " " " " " + " "	+
.007 " " " " " + " "	+
.167 " " " " " + " glucose	−
.133 " " " " " + " "	−
.100 " " " " " + " "	−
.067 " " " " " + " "	−
.033 " " " " " + " "	−
.017 " " " " " + " "	+
.007 " " " " " + " "	+
.005 " " " " " + " "	+
.004 " " " " " + " "	+
.167 " " " " " + " fructose	−
.133 " " " " " + " "	−
.100 " " " " " + " "	−
.067 " " " " " + " "	−
.033 " " " " " + " "	−
.017 " " " " " + " "	−
.007 " " " " " + " "	+
.005 " " " " " + " "	+
.004 " " " " " + " "	+
.167 " " " " " + " "	o
.133 " " " " " + " "	o
.100 " " " " " + " "	o
.067 " " " " " + " "	−
.033 " " " " " + " "	−
.017 " " " " " + " "	+
.007 " " " " " + " "	+
.005 " " " " " + " "	+
.004 " " " " " + " "	+
distilled water + " peptone	+
" " + " glucose	+
" " + " fructose	+
" " + " galactose	+

media inhibits the germination of the spores; in a concentration of 0.017 molar, the spores germinate and produce microscopic mycelia. Aluminum nitrate in starch media is more than ten times as toxic as in peptone media. Its toxicity in glucose media is approximately the same as in starch media. It is much less

TABLE IV

THE TOXICITY OF ALUMINUM NITRATE IN PEPTONE, GLUCOSE, FRUCTOSE, AND GALACTOSE MEDIA

Medium										Growth after 11 days
.167	molar	solution	of	aluminum	nitrate	+	5%	peptone	.....	o
.133	"	"	"	"	"	+	"	"	.....	o
.100	"	"	"	"	"	+	"	"	.....	o
.067	"	"	"	"	"	+	"	"	.....	o
.033	"	"	"	"	"	+	"	"	.....	o
.017	"	"	"	"	"	+	"	"	.....	−
.007	"	"	"	"	"	+	"	"	.....	+
.004	"	"	"	"	"	+	"	"	.....	+
.167	"	"	"	"	"	+	"	glucose	.....	o
.133	"	"	"	"	"	+	"	"	.....	o
.100	"	"	"	"	"	+	"	"	.....	o
.067	"	"	"	"	"	+	"	"	.....	o
.033	"	"	"	"	"	+	"	"	.....	o
.017	"	"	"	"	"	+	"	"	.....	o
.006	"	"	"	"	"	+	"	"	.....	o
.003	"	"	"	"	"	+	"	"	.....	o
.0007	"	"	"	"	"	+	"	"	.....	+
.167	"	"	"	"	"	+	"	fructose	.....	o
.133	"	"	"	"	"	+	"	"	.....	o
.100	"	"	"	"	"	+	"	"	.....	o
.067	"	"	"	"	"	+	"	"	.....	o
.033	"	"	"	"	"	+	"	"	.....	o
.017	"	"	"	"	"	+	"	"	.....	o
.007	"	"	"	"	"	+	"	"	.....	o
.002	"	"	"	"	"	+	"	"	.....	o
.001	"	"	"	"	"	+	"	"	.....	o
.0007	"	"	"	"	"	+	"	"	.....	−
.167	"	"	"	"	"	+	"	galactose	.....	o
.133	"	"	"	"	"	+	"	"	.....	o
.100	"	"	"	"	"	+	"	"	.....	o
.067	"	"	"	"	"	+	"	"	.....	o
.033	"	"	"	"	"	+	"	"	.....	o
.017	"	"	"	"	"	+	"	"	.....	o
.007	"	"	"	"	"	+	"	"	.....	o
.004	"	"	"	"	"	+	"	"	.....	o
.003	"	"	"	"	"	+	"	"	.....	o
.001	"	"	"	"	"	+	"	"	.....	−
.0007	"	"	"	"	"	+	"	"	.....	+
				distilled	water	+	"	peptone	.....	+
				"	"	+	"	glucose	.....	+
				"	"	+	"	fructose	.....	+
				"	"	+	"	galactose	.....	+

toxic in peptone media than in glucose or starch media. It is less toxic in starch media and in peptone media than in glucose media and in fructose media. In galactose it is less toxic than in fructose. Barium nitrate, on the other hand, is much more toxic in galactose media than in fructose media.

TABLE V

THE TOXICITY OF FERRIC NITRATE IN PEPTONE, GLUCOSE, FRUCTOSE, AND GALACTOSE MEDIA

Medium									Growth after 11 days
.0067	molar	solution	of	ferric	nitrate	+	5%	peptone	+
.0053	"	"	"	"	"	+	"	"	+
.0040	"	"	"	"	"	+	"	"	+
.0027	"	"	"	"	"	+	"	"	+
.0013	"	"	"	"	"	+	"	"	+
.0007	"	"	"	"	"	+	"	"	+
.0004	"	"	"	"	"	+	"	"	+
.0003	"	"	"	"	"	+	"	"	+
.0001	"	"	"	"	"	+	"	"	+
.0067	"	"	"	"	"	+	"	glucose	o
.0053	"	"	"	"	"	+	"	"	o
.0040	"	"	"	"	"	+	"	"	o
.0027	"	"	"	"	"	+	"	"	o
.0013	"	"	"	"	"	+	"	"	o
.0007	"	"	"	"	"	+	"	"	o
.0005	"	"	"	"	"	+	"	"	−
.0004	"	"	"	"	"	+	"	"	+
.0003	"	"	"	"	"	+	"	"	+
.0001	"	"	"	"	"	+	"	"	+
.0067	"	"	"	"	"	+	"	fructose	o
.0007	"	"	"	"	"	+	"	"	−
.0001	"	"	"	"	"	+	"	"	+
.0067	"	"	"	"	"	+	"	galactose	o
.0053	"	"	"	"	"	+	"	"	o
.0040	"	"	"	"	"	+	"	"	o
.0027	"	"	"	"	"	+	"	"	o
.0013	"	"	"	"	"	+	"	"	o
.0007	"	"	"	"	"	+	"	"	o
.0005	"	"	"	"	"	+	"	"	o
.0004	"	"	"	"	"	+	"	"	−
.0003	"	"	"	"	"	+	"	"	+
.0001	"	"	"	"	"	+	"	"	+
				distilled	water	+	"	peptone	+
				"	"	+	"	glucose	+
				"	"	+	"	fructose	+
				"	"	+	"	galactose	+

As shown by TABLE V, ferric nitrate at a concentration of 0.0067 molar, does not hinder the growth of *Monilia* in peptone media. In glucose media it inhibits the germination of the spores, when present at a concentration of 0.0007 molar. The small amount of mycelium obtained in fructose media containing ferric nitrate at a concentration of 0.0007 molar indicates that this is near its limit concentration in this medium. It is more toxic in galactose than in fructose media,—but is much less toxic in peptone than in any of the other media used.

TABLE VI

THE TOXICITY OF UREA NITRATE AND AMMONIUM NITRATE IN PEPTONE MEDIA

Medium		Growth after 11 days
.200 molar solution of urea nitrate	+ 5% peptone	−
.133 " " " " "	+ " "	+
.067 " " " " "	+ " "	+
.033 " " " " "	+ " "	+
.027 " " " " "	+ " "	+
.020 " " " " "	+ " "	+
.013 " " " " "	+ " "	+
.007 " " " " "	+ " "	+
.133 " " " ammonium tartrate	+ " "	o
.067 " " " " "	+ " "	o
.060 " " " " "	+ " "	o
.053 " " " " "	+ " "	o
.047 " " " " "	+ " "	o
.040 " " " " "	+ " "	o
.033 " " " " "	+ " "	o
.027 " " " " "	+ " "	−
.020 " " " " "	+ " "	−
.013 " " " " "	+ " "	−
.007 " " " " "	+ " "	+
distilled water	+ " "	+

The small amount of growth obtained in peptone media containing urea nitrate at a concentration of 0.2 molar indicates that this is approximately its limit concentration. In peptone media containing ammonium tartrate at a concentration of 0.027 molar, only microscopic mycelia were obtained. The toxicity of urea nitrate in starch media is four times as great as its toxicity in peptone media. The toxicity of ammonium tartrate, on the other hand, is approximately the same in starch as in peptone media.

TABLE VII

THE INFLUENCE OF PEPTONE ON THE TOXICITY OF FERRIC NITRATE IN STARCH MEDIA

Medium	Growth after 11 days
.0067 molar solution of ferric nitrate + 5% starch	o
.0067 " " " " " + " " + 1% peptone	o
.0067 " " " " " + " " + 2% "	−
.0067 " " " " " + " " + 3% "	−
.0067 " " " " " + " " + 4% "	+
.0067 " " " " " + " " + 5% "	+
.0067 " " " " " + " " + 6% "	+
.0067 " " " " " + " " + 7% "	+
.0067 " " " " " + " " + 8% "	+
.0067 " " " " " + " " + 9% "	+

TABLE VII shows the degree to which peptone counteracts the toxicity of ferric nitrate in starch media. When only 1 per cent of peptone was added to this medium none of the spores germinated; when 2 per cent of peptone was added the spores germinated and produced microscopic mycelia, but when 4 per cent of peptone was added vigorous growth was obtained.

TABLE VIII

THE TOXICITY OF VARIOUS SALTS IN SOME COMMON MEDIA

Toxic concentration	Salt	Medium
.156 molar	barium nitrate	starch
.067 "	" "	peptone
.167 "	" "	glucose
.167 "	" "	fructose
.067 "	" "	galactose
.0013 "	aluminum "	starch
.0170 "	" "	peptone
.0070 "	" "	glucose
.0007 "	" "	fructose
.0013 "	" "	galactose
.00067 "	ferric "	starch
.00670 "	" "	peptone
.00050 "	" "	glucose
.00070 "	" "	fructose
.00040 "	" "	galactose
.05 "	urea "	starch
.20 "	" "	peptone
.025 "	ammonium tartrate	starch
.027 "	" "	peptone

As shown by the above table, barium nitrate is more toxic in peptone and galactose than in the other media. Aluminum nitrate

and ferric nitrate, on the other hand, are far less toxic in peptone than in the other substances used. Urea nitrate is more toxic in starch media than in peptone media, while the toxicity of ammonium tartrate is the same in the two media.

DISCUSSION

My observations show beyond question that the concentration at which various inorganic salts are toxic to *Monilia sitophila* depends on the kind of organic substances contained in the media to which those salts are added. The same substance at a given concentration may be highly toxic in one medium but quite harmless in another. The concentration of ferric nitrate that inhibits the growth of *Monilia* in starch media has little or no effect upon its growth in peptone media. Lipman (**3**), using a peptone medium, found that calcium chloride is more toxic to *Bacillus subtilis* than is potassium chloride, sodium chloride, or magnesium chloride. My experiments suggest that he might have obtained a different result by adding these chlorides to a medium containing starch or sugar instead of peptone. Ssadikow (**5**) has tested the toxicity of strychnin salts to *Bacillus subtilis*, using as his media, bouillon, nutrient agar, and nutrient gelatin. He found this organism able to withstand a surprisingly high concentration of these salts. A very different result might have been obtained if the strychnin salts had been added to media lacking in peptone.

We have in such experiments, it seems to me, a means of attacking the whole question as to the nature of toxicity and toxic effects from an important and rather neglected standpoint and I hope to extend this work to a study of still other combinations of toxic and non-toxic substances as regards their effects on various living organisms. It is also obvious that such data are necessary to a proper understanding of the effects of various food substances, drugs, etc., both from the standpoint of the significance of the medium with which the chemical is combined when offered as a food and from the standpoint of its relation to the organic reserve and other substances which it meets in the cell.

SUMMARY

1. The degree of toxicity of barium nitrate, aluminum nitrate, ferric nitrate, and urea nitrate to *Monilia sitophila* depends on the organic substance contained in the media in which these salts are offered.

2. Barium nitrate is more toxic in peptone media than in starch media, while aluminum nitrate and ferric nitrate are more toxic in starch media than in peptone media.

3. Barium nitrate has practically the same toxicity in starch media that it has in either glucose or fructose media. Its toxicity in peptone media is the same as its toxicity in galactose media.

4. The toxicity of aluminum nitrate in galactose media is the same as its toxicity in starch media. Its toxicity in fructose is much greater than in peptone or glucose.

5. The toxicity of ferric nitrate is approximately the same in starch as in glucose, fructose, or galactose. Its toxicity in peptone, however, is much less than in any of the other substances used.

6. Urea nitrate is four times more toxic in starch media than in peptone media.

7. The toxicity of ammonium tartrate is practically the same in starch as in peptone media.

8. If the limit concentration of zinc nitrate in starch media be taken as 1, then the limit concentration of the other nitrates in the same kind of media may be expressed, by comparing equimolecular concentrations, approximately by the following numbers: silver nitrate, 5; ferric nitrate, 26; aluminum nitrate, 52; ammonium nitrate, 1,520; urea nitrate, 1,600; calcium nitrate, 16,560; and potassium nitrate, 53,200.

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Resistance of the prothallia of Camptosorus rhizophyllus to desiccation *

F. L. Pickett

Camptosorus rhizophyllus (L.) Link is found growing with mosses and lichens on the shaded surface of dry limestone ledges and on detached limestone slabs in open ravines and torrent beds. Only rarely have groups been found in well-shaded or continually moist places in this region (southern Indiana). Growing in places thus exposed without constant water supply, the plants are subjected to brief periods of abundant moisture (during and immediately after precipitation) which alternate with longer periods of drought. That plants with a delicate prothallial stage in their life history could secure and retain residence under such conditions has been a cause for surprise.

The drought-resisting power of some greenhouse cultures of this fern grown in the spring of 1912 suggested a possible adaptation to its well-known xerophytic habitat. In an attempt to determine to what extent this ability to withstand drought might be a factor in adaptation, fronds with mature spores were collected in October, 1912, and cultures were made as usual on sterilized soil in clay saucers. These cultures were subjected to a variety of conditions to be later enumerated.

An attempt was made to obtain information on the following points: the uniformity of spore germination and prothallial development, the ability of prothallia to resist or survive natural drought conditions, and the ability to survive conditions leading to complete desiccation.

Fronds were collected on October 26, 1912, and kept between sheets of filter paper in a book in the laboratory. The sporangia were lightly crushed to free the spores and then sown on thoroughly sterilized soil, November 22, 1912. The cultures were kept in the greenhouse and were protected by bell-jars supported on

* The writer has been unable to find any literature bearing upon this subject, for the prothallia of this or any other homosporous fern.

small blocks of wood to provide adequate ventilation. Some cultures were exposed to direct sunlight while others were exposed to strong diffused light only. The temperature conditions were the same, 20–25° C. The soil was kept moist, not wet, but was allowed to show a dry surface for a period of 12 to 24 hours once each week. The first green was noticed December 17, at which time the prothallia when examined with a microscope were found to be composed of two to ten cells each. These cultures showed good growth, seeming to suffer no injury from the dry periods. Those in the sunlight showed rather a more rapid development than those in diffused light. On February 11, 1913, the culture in sunlight contained prothallia in good condition but varying in size from merely germinated spores up to plants 2–3 mm. broad with but very few antheridia or archegonia. The culture in diffused light did not show similar prothallia until March 21, 1913.

The spores of *Camptosorus rhizophyllus* germinate very irregularly. Twelve weeks after the spores were sown, a small bit of soil—not over 3 mm. square—removed from a culture where the plants seemed most thrifty, showed all stages in development from spores with the perinium just ruptured to prothallia bearing mature antheridia and archegonia. Many spores retain their vitality up to May in the dry atmosphere of the laboratory, and fronds collected in March furnished viable spores for cultures. The long dormant period of spores on the moist soil of cultures suggests that they might remain so on the soil of their habitat through the winter season.

Four methods of reducing water content were used. First, a glycerin desiccator was used, consisting of two glass vials through which, by means of an aspirator, a current of air was drawn after passing through two U-tubes containing glycerin and crumpled filter paper. Heaviest c.p. glycerin was used. The aspirator was arranged so that the air of the vials was changed about one hundred times each twenty-four hours. Second, cultures were left under bell-jars, exposed to the warm air and full sunlight of the greenhouse. Third, cultures were left under bell-jars, exposed to the dry air and diffused light of the greenhouse lobby or vestibule at a slightly lower temperature, 16–20° C. This place represents as nearly as possible the natural growth

conditions. In the second and third cases full ventilation was secured by allowing the jars to rest on blocks of wood 2 cm. high. Fourth, large portions of a culture were placed in a desiccator over c.p. sulphuric acid and the whole apparatus was kept in a cool, moderately lighted location. In all cases, when soil and prothallia were removed from a dry chamber they were placed in contact with moist soil under a bell-jar subject to full diffused light at a temperature of 16–20° C., for recovery. Examination for dead prothallia was made after three or four days under such conditions. Extreme care was taken at all times when removing portions of cultures to or from the dry chambers, to leave the prothallia as far as possible undisturbed and uninjured.

Results—glycerin desiccator.—A large portion of the soil of a culture was removed to the vial of the desiccator and allowed to remain in the dry air undisturbed, except as small portions were removed for recovery and growth. Specimens placed in the desiccator on March 22 seemed to revive completely up to April 22, at which time a few small dead prothallia were found in a portion removed. Another portion removed April 29 showed about 50 per cent of the prothallia dead. The last of the soil and prothallia was removed May 5. All the smaller plants and all but a very few of the larger plants were dead at that time.

In this set of experiments a very few fully matured prothallia survived continuous exposure to dry air for forty-four days. Very few were damaged by such exposure for a period of thirty days. That the recovery was complete in case of survival is proven by the continued growth of the prothallia and their later production of sporophytes.

That vigorous desiccation follows immediately after the plants were placed in the vials is shown by the fact that the soil had given up all free moisture in twenty-four hours after being placed therein. As a check, at the beginning of this experiment a clump of thrifty mature prothallia of *Onoclea Struthiopteris* was placed in one of the vials. After forty-eight hours' exposure to the dry air not one plant recovered.

A similar set of experiments was arranged with the whole apparatus exposed to the direct sunlight. Most of the prothallia so exposed were dead at the end of twenty-eight days, and all were dead after thirty-five days of exposure.

Results—sulphuric acid desiccator.—A portion of soil bearing prothallia was removed to a porcelain dish in a desiccator containing c.p. sulphuric acid. The lid was sealed down with vaseline and the apparatus placed in diffused light at a temperature of 16–20° C. After eighteen hours the prothallia showed a marked yellowish color. A portion removed after four days showed a recovery of but two or three per cent. The plants removed at this time recovered very slowly, requiring a week to resume a normal appearance.

Results—normal dry air.—The soil mass of a culture was divided into two approximately equal parts and carefully removed to sterilized clay saucers. One portion was placed under a bell-jar exposed to the full sunlight in the greenhouse. The other was kept under a bell-jar exposed to full diffused light and at a temperature of 16–20° C., an average of four degrees lower than that for the first portion. After three weeks, but a few of the plants exposed to direct sunlight recovered, and all were dead after five weeks of such exposure. Of the second lot not exposed to direct sunlight a portion removed after thirty-four days showed almost complete recovery. After fifty-five days, about 25 per cent of the prothallia recovered. After sixty-three days, a very few of the largest plants recovered and continued to grow.

The conditions under which the second group of plants was kept approximate very closely the summer conditions in the regular habitat of *Camptosorus rhizophyllus*. The results of that set of experiments certainly suggest an explanation of this plant's abundant growth under such conditions. It should be noted here, as above, that full recovery of the plants has been demonstrated by their continued growth and later production of sporophytes. If mature prothallia can withstand continuous drought for two months, they would certainly survive the difficulties of the average season after late March, at which time spores may germinate outside. The occasional rains through the summer would make possible recovery, fertilization, and the production of sporophytes.

In connection with this set of experiments another should be noticed. A culture was prepared as for all the above on November 25, 1912. The drainage was such that a part of the soil

surface was dry at all times, except when occasionally flooded. The remaining portion was moist as in the other cultures. All gradations of moisture were in evidence in and between the two regions. Small prothallia were seen on December 18 on the damp soil. On March 1, 1913, most of the prothallia of this region showed mature sex organs. The drier portions at the latter date showed germinating spores, dwarf male prothallia, and later stages in development up to mature plants. After March 1, this culture was watered irregularly and was allowed to become quite dry each time before more water was applied. After April 15 the culture was screened from the direct sun. Water was occasionally applied so as to flood the whole surface. On May 5 there were many living prothallia and several young sporophytes. On June 9 there were several large, living prothallia and the young sporophytes were uninjured, although during the previous month the culture had been four times dry, once for seventy-two hours.

SUMMARY

As has been stated above, the experiment of subjecting prothallia to normal dry air without direct sunlight,—continuous conditions approximating the average of varying conditions found in nature,—has shown that the production of mature prothallia under such conditions is possible. The other experiments of subjecting prothallia to more thorough desiccation in the glycerin desiccator and over sulphuric acid show the possibility of surviving the extreme conditions found in nature. There can remain but little doubt that the drought-resisting character of the prothallia is a very effective factor in the adaptation of *Camptosorus rhizophyllus* to its habitat.

INDIANA UNIVERSITY, BLOOMINGTON

INDEX TO AMERICAN BOTANICAL LITERATURE

(1913)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Anthon, S. I. The surprise lily. Am. Bot. **19**: 81–83. Au 1913. [Illust.]

Calochortus macrocarpus.

Bailey, W. W. Transient botanizing. Am. Bot. **19**: 98, 99. Au 1913.

Bartholomew, E. T. Black heart of potatoes. Phytopathology **3**: 180–182. *pl. 19.* 14 Au 1913.

Bitter, G. *Solana* peruv., aequat., boliv. Bot. Jahrb. Beibl. **50**: 58–67. 19 Au 1913.

Includes 7 new species in *Solanum.*

Blodgett, F. M. Hop mildew. Cornell Univ. Agr. Exp. Sta. Bull. 328: 281–310. *f. 93–1 1.* Mr 1913.

A disease caused by *Sphaerotheca Humuli.*

Börgesen, F. The marine algae of the Danish West Indies. Part I. *Chlorophyceae.* 1–160. *f. 1–126 + chart.* Copenhagen. 1913.

Includes *Pringsheima Udoteae, Cladophora uncinata, C. corallicola,* and *Avrainvillea Geppii,* spp. nov.

Brand, A. *Polemoniaceae* peruvianae et bolivienses. Bot. Jahrb. Beibl. **50**: 50–52. 19 Au 1913.

Includes *Huthia longiflora* sp. nov.

Brown, P. E. Media for the quantitative determination of bacteria in soils. Centralb. Bakt. Zweite Abt. **38**: 497–506. 9 Au 1913.

Burger, O. F. A bacterial rot of cucumbers. Phytopathology **3**: 169, 170. 14 Au 1913.

Clute, W. N. The day lilies. Am. Bot. **19**: 86–90. Au 1913. [Illust.]

Cogniaux, A. *Cucurbitaceae* andinae. Bot. Jahrb. Beibl. **50**: 75–76. 19 Au 1913.
Includes ***Apodanthera eriocalyx*** sp. nov.

Cogniaux, A. *Melastomataceae* peruvianae. II. Bot. Jahrb. Beibl. **50**: 31–33. 19 Au 1913.
Includes ***Tibouchina fulvipilis*** and ***Axinaea Weberbaueri***, spp. nov.

Collins, F. S. Three plants with extension of range. Rhodora **15**: 169, 170. 1 S 1913.
Panicum Bicknellii, ***Potentilla tridentata***, and ***Juncus bufonius var. halophilus***.

Collins, G. N. Mosaic coherence of characters in seeds of maize. U. S. Dept. Agr. Plant Ind. Circ. 132: 19–21. 19 Je 1913.

Cook, M. T., & Schwarze, C. A. A *Botrytis* disease of dahlias. Phytopathology **3**: 171–173. *pl. 17*. 14 Au 1913.

Dammer, U. *Solanaceae* americanae. II. Bot. Jahrb. Beibl. **50**: 52–58. 19 Au 1913.
Includes 6 new species in ***Dunalia***.

Fawcett, H. S. Two fungi as casual agents in gummosis of lemon trees in California. Phytopathology **3**: 194, 195. Je 1913. Also published in Monthly Bull. State Comm. Hort. Calif. **2**: 601–617. *f. 340–351*. Au 1913.
Botrytis vulgaris and ***Pythiacystis citrophthora***.

Fernald, M. L. A peculiar variety of the canoe birch. Rhodora **15**: 168, 169. 1 S 1913.

Ferry, R. Étude sur les Amanites. Premier Supplément Rev. Myc. **1911**: 1–96. *pl. 1–8*. 14 Je 1911.

Fletcher, E. F. Further wool-waste plants at Westford, Massachusetts. Rhodora **15**: 172. 1 S 1913.

Fromme, F. D. The culture of cereal rusts in the greenhouse. Bull. Torrey Club **40**: 501–521. 10 S 1913.

Geckler, A. *Echinocactus Droegeanus* Hildm. Monats. Kakteenk. **23**: 122. 15 Au 1913.

Gilg, E. *Gentianaceae* andinae. Bot. Jahrb. Beibl. **50**: 48–50. 19 Au 1913.
Includes five new species in ***Gentiana*** and one in ***Macrocarpaea***.

Gilg, E. *Malesherbiaceae* andinae. II. Bot. Jahrb. Beibl. **50**: 11, 12. 19 Au 1913.
Includes ***Malesherbia Weberbaueri*** and ***M. scarlatiflora***, spp. nov.

Griggs, R. F. Observations on the geographical composition of the Sugar Grove flora. Bull. Torrey Club **40**: 487–499. *f. 1–10.* 10 S 1913.

Güssow, H. T. The barberry and its relation to black rust of grain. Phytopathology **3**: 178, 179. 14 Au 1913.

Harris, J. A. An illustration of the influence of substratum heterogeneity upon experimental results. Science II. **38**: 345, 346. 5 S 1913.

Harter, L. L., & Field, E. C. A dry rot of sweet potatoes caused by *Diaporthe Batatatis.* U. S. Dept. Agr. Plant Ind. Bull. 281: 7–38. *pl. 1–4+f. 1–4.* 1 My 1913.

Heribert-Nilsson, N. *Oenothera*-problemet. Svensk Bot. Tidsk. **7**: 1–16. 25 Mr 1913. [Illust.]

Herter, W. José Arechavaleta. Monats. Kakteenk. **23**: 125–127. 15 Au 1913.

Hill, G. R. Respiration of fruits and growing plant tissues in certain gases, with reference to ventilation and fruit storage. Cornell Univ. Agr. Exp. Sta. Bull. 330: 377–408. Ap 1913.

Hull, E. D. Advance of *Potamogeton crispus* L. Rhodora **15**: 171, 172. 1 S 1913.

Johnston, J. R. The nature of fungous diseases of plants. Porto Rico Sugar Producers' Assoc. Circ. 2: 3–25. *f. 1–9.* My 1913.

Jostmann, A. *Pilocereus lanatus* (H. B. K.) Web. var. *Haagei* (Poselg.) Schelle. Monats. Kakteenk. **23**: 125. 15 Au 1913. [Illust.]

Kellerman, K. F. The use of congo red in culture media. U. S. Dept. Agr. Plant Ind. Circ. 130: 15–17. 21 Je 1913.

Keyser, A. Variation studies in brome grass. (A preliminary report). Colorado Agr. Exp. Sta. Bull. 190: 3–20. *pl. 1–19.* Je 1913.

Kränzlin, F. *Amaryllidaceae* peruvianae, bolivienses, brasilienses. Bot. Jahrb. Beibl. **50**: 2–5. 19 Au 1913.

Includes ***Collania Herzogiana***, ***Bomarea Ulei***, ***B. Loreti***, and ***Eucharis Ulei***, spp. nov.

Kränzlin, F. *Buddleiae* americanae nonullis gerontogaeis adjectis. Bot. Jahrb. Beibl. **50**: 33–47. 19 Au 1913.

Includes 22 new species in ***Buddleia***.

Kränzlin, F. *Calceolariae* peruv., aequat., argent. Bot. Jahrb. Beibl. **50**: 67–75. 19 Au 1913.

Includes 9 new species in ***Calceolaria***.

Loesner, T. *Celastraceae* andinae. II. Bot. Jahrb. Beibl. **50**: 8–10. 19 Au 1913.

Includes ***Maytenus apurimacensis*** and ***M. andicola***, spp. nov.

Meinecke, E. P. Notes on *Cronartium coleosporioides* Arthur and *Cronartium filamentosum*. Phytopathology **3**: 167, 168. 14 Au 1913.

Morse, W. J. Some borrowed ideas in laboratory equipment. Phytopathology **3**: 175–177. *pl. 18*. 14 Au 1913.

Muschler, R. *Caryophyllacea* aequatoriana. Bot. Jahrb. Beibl. **50**: 5, 6. 19 Au 1913.

Drymaria adiantoides sp. nov.

Muschler, R. *Compositae* peruv. et boliv. II. Bot. Jahrb. Beibl. **50**: 76–108. 19 Au 1913.

Includes 29 new species in *Mikania* (1), *Liabum* (9), *Gynoxis* (6), *Chuquiraga* (3), *Onoseris* (4), *Barnadesia* (5), *Mutisia* (3), and *Jungia* (3).

Muschler, R. *Crucifera* peruviana. Bot. Jahrb. Beibl. **50**: 7, 8. 19 Au 1913.

Cremolobus stenophyllus sp. nov.

Orton W. A. International phytopathology and quarantine legislation. Phytopathology **3**: 144–151. 14 Au 1913.

Pilger, R. Biologie und Systematik von *Plantago* § *Novorbis*. Bot. Jahrb. **50**: 171–287. *f. 1–30*. 19 Au 1913.

Includes ***Plantago taraxacoides, P. hypoleuca, P. pseudomyosuros, P. chubutensis, P. ecuadorensis, P. Berroi, P. achalensis, P. Buchtienii, P. macropus, P. Niederleinii, P. Arechavaletai, P. ventanensis, P. denudata, P. valida***, spp. nov., and many new varieties from America.

Pilger, R. *Graminea* peruviana. Bot. Jahrb. Beibl. **50**: 1, 2. 19 Au 1913.

Trichoneura Weberbaueri sp. nov.

Pilger, R. *Rosacea* peruviana. Bot. Jahrb. Beibl. **50**: 8. 19 Au 1913.

Prunus huantensis sp. nov.

Prescott, A. The moonwort. Am. Bot. **19**: 95–97. Au 1913. [Illust.]

Putnam, B. L. Our native *Aquilegia*. Am. Bot. **19**: 97. Au 1913.

Rydberg, P. A. Studies on the Rocky Mountain flora—XXIX. Bull. Torrey Club **40**: 461–485. 10 S 1913.

Includes 26 new species in *Hypopitys* (1), *Primula* (1), *Androsace* (2), *Amarella* (1), *Hydrophyllum* (1), *Anthopogon* (1), *Dasystephana* (2), *Amsonia* (1), *Cressa* (1), *Cuscuta* (1), *Gilia* (5), *Leptodactylon* (1), *Polemonium* (2), *Phacelia* (1), *Oreocarya* (2), *Pentstemon* (1), *Mimulus* (1), and *Castilleja* (1).

Saunders, C. F. Wild soaps. Am. Bot. **19**: 99, 100. Au 1913.

Schellenberg, G. *Berberidacea* peruviana. Bot. Jahrb. Beibl. **50**: 6, 7. 19 Au 1913.

Berberis peruviana sp. nov.

Schellenberg, G. *Frankeniacea* peruviana. Bot. Jahrb. Beibl. **50**: 10, 11. 19 Au 1913.

Frankenia peruviana sp. nov.

Shear, C. L. The type of *Sphaeria radicalis* Schw. Phytopathology **3**: 191, 192. 14 Au 1913.

Stewart, V. B. The fire blight disease in nursery stock. Cornell Univ. Agr. Exp. Sta. Bull. 329: 317–371. *f. 112–126.* Ap 1913.

Sturgis, W. C. *Herpotrichia* and *Neopeckia* on conifers. Phytopathology **3**: 152–158. *pl. 12, 13.* Je 1913.

Swingle, W. T. *Feroniella*, genre nouveau de la tribu des *Citreae*, fondé sur le *F. oblata*, espèce nouvelle de l'Indo-Chine. Bull. Soc. Bot. France **59**: 774–783. *pl. 18.* 18 F 1912.

Sydow, H. & P. Novae fungorum species—X. Ann. Myc. **11**: 254–271. *f. 1–8.* Je 1913.

Includes *Sphaerulina salicina* from North Dakota, ***Phyllachora atro-maculans*** and *Dothidella Picramniae* from Costa Rica.

Taubenhaus, J. J. The black rots of the sweet potato. Phytopathology **3**: 159–166. *pl. 14–16.* Au 1 13.

Includes ***Sclerotium bataticola*** sp. nov.

Thomson, R. B. On the comparative anatomy and affinities of the *Araucarineae*. Philos. Trans. Royal Soc. London B **204**: 1–50. *pl. 1–7.* 7 My 1913.

Trelease, W. *Furcraea* peruviana. Bot. Jahrb. Beibl. **50**: 5. 19 Au 1913.

Furcraea occidentalis sp. nov.

Tullsen, H. *Pentstemon grandiflorus.* Am. Bot. **19**: 84, 85. Au 1913. [Illust.]

Urban, I. Plantae novae andinae imprimis Weberbaurinae. VI. Bot. Jahrb. Beibl. **50**: 1–108. 19 Au 1913.

Consists of 19 separate papers here indexed under their respective authors: Bitter, Brand, Cogniaux, Dammer, Gilg, Kränzlin, Loesener, Muschler, Pilger, Schellenberg, Trelease, and Vaupel.

Vaupel, F. *Cactaceae* andinae. Bot. Jahrb. Beibl. **50**: 12–31. 19 Au 1913.

Includes ***Cephalocereus melanostele, Cereus acanthurus, C. apiciflorus, C. brachypetalus, C. decumbens, C. micranthus, C. plagiostoma, C. squarrosus, C. Weberbauri, Echinocactus aurantiacus, E. molendensis, E. myriacanthus, E. Weberbaueri, Opuntia dactylifera,*** and ***O. ignescens,*** spp. nov.

Vaupel, F. Sieben neue *Cactaceae.* Monats. Kakteenk. **23**: 105–107. 15 Jl 1913.

Vaupel, F. Verzeichnis der seit der Herausgabe des I. Nachtrages zu K.

Schumann's "Gesamtbeschreibung der Kakteen" (1903) neu beschriebenen und umbenannten Gattungen und Arten aus der Familie der *Cactaceae*. Monats. Kakteenk. **23**: 11–14. 15 Ja 1913; 23–27. 15 F 1913; 37–41. 15 Mr 1913; 56–60. 15 Ap 1913; 72–78. 15 My 1913; 81–88. 15 Je 1913.

Weingart, W. *Cereus Hirschtianus* K. Schum. Monats. Kakteenk. **23**: 108–111. 15 Jl 1913.

Weir, J. R. *Auricularia mesenterica* (Dicks.) Pers. Phytopathology **3**: 192. Au 1913.

Wellington, R. Mendelian inheritance of epidermal characters in the fruit of *Cucumis sativus*. Science II. **38**: 61. 11 Jl 1913.

Wernham, H. F. New *Rubiaceae* from tropical America—II. Jour. Bot. **51**: 218–221. Jl 1913.

Includes eleven new species in *Pteridocalyx* (1), *Tournefortiopsis* (1), *Gonzalea* (4), *Machaonia* (3), *Malanea* (1), and *Cephaelis* (1).

Wester, P. J. Annonaceous possibilities for the plant breeder. Philip. Agr. Rev. **6**: 312–321. *pl. 2–7*. Jl 1913.

Westling, R. Über die grünen Spezies der Gattung *Penicillium*. Arkiv Bot. **11**[1]: 1–156. *f. 1–81*. 1911.

Discusses several American species.

Williams, R. S. *Dicranaceae*. N. Am. Fl. **15**: 77–158. 8 Au 1913.

Includes new species in *Dicranella* (2), *Dicranum* (1), and *Campylopus* (4).

Williams, R. S. *Leucobryaceae*. N. Am. Fl. **15**: 159–166. 8 Au 1913.

Includes *Octoblepharum erectifolium* Mitten sp. nov.

Wilson, G. W. *Fusarium* or *Verticillium* on okra in North Carolina? Phytopathology **3**: 183–185. Je 1913.

Wolf, F. A. Melanose. Phytopathology **3**: 190, 191. 14 Au 1913.

Yamanouchi, S. The life history of *Zanardinia*. Bot. Gaz. **56**: 1–35. *pl. 1–4+f. 1–24*. 16 Jl 1913.

York, H. H. The origin and development of the embryo sac and embryo of *Dendrophthora opuntioides* and *D. gracile[is]*. I. Bot. Gaz. **56**: 89–111. *pl. 5, 6 + f. 1, 7, 8, 12a, 20, 21*. 14 Au 1913; II. Bot. Gaz. **56**: 200–216. *pl. 7*. 17 S 1913.